Predictability of How Single-Family Home Values Respond to a Changing Neighborhood: The Case of Oxford, CT

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ABSTRACT

In this paper we conduct a high-level review of the literature regarding factors that impact the prices of single-family residential real estate properties. In particular, we focus on the impact that exogenous events can, may, or will likely have on residential real estate values. We then turn our attention to a specific situation: the construction of a fossil fuel power generation facility (primarily using natural gas) in Oxford, CT. Because the facility has been licensed for this site since 1999, and is co-located with a long-established, busy airport and multiple industrial parks, we conclude that available research does not support the contention that either the construction or completion of the power plant will have any material impact on residential real estate values in the surrounding area.

ABOUT CCEA

The Connecticut Center for Economic Analysis (CCEA) is a University Center located within the School of Business at the University of Connecticut (UCONN); CCEA specializes in economic impact and policy analysis studies as well as advising clients regarding business strategy, market analysis, and related topics. CCEA focuses particular attention on the economic and business dynamics of Connecticut, for which CCEA maintains a license to dynamic REMI models of the state's economy.

CCEA was created at the request of Governor Weicker in 1992 to serve the state's citizens by providing timely and reliable information regarding Connecticut's economy and to evaluate the potential impacts of proposed policies and strategic investments. By mobilizing and directing the expertise available at the UCONN, state agencies, and the private sector, CCEA aims to equip the public and decision makers with transparent analyses to facilitate systematic, thoughtful debate of public policy issues.

CCEA has conducted hundreds of studies involving the Connecticut economy, at both the state and local levels. Copies of its studies and reports that are available to the general public, can be found at http://ccea.uconn.edu/. For additional information about CCEA, please contact Professor Fred Carstensen (fred.carstensen@uconn.edu).

INTRODUCTION

According to the Board of Governors of the Federal Reserve System, total U.S. mortgage debt outstanding peaked in the 2nd quarter of 2008 at $14.8 trillion. In the years that followed, that amount declined mildly. At the end of September 2014, total mortgage debt was $13.3 trillion.[i] By way of comparison, the U.S. Department of Commerce Bureau of Economic Analysis (BEA) estimates that, for 2014, the country's real gross domestic product (RGDP) – "the value of the production of goods and services in the United States, adjusted for price changes"; in other words, the entire output of the United States' economy – will be around $16 trillion.[ii] For an additional comparison, the total value of all the stocks in the S&P 500 is currently around $1.6 trillion.[iii]

As large as the aforementioned figures are, the actual value of residential real estate is even larger. According to the Fed's Flow of Funds report[iv], in September 2014, households had just over $20 trillion in real estate holdings. Even assuming that this figure is only a rough estimate, the numbers clearly indicate that residential real estate has major economic significance, not only for individuals, but also in terms of our national economy. If the numbers alone fail to underscore the importance of the real estate market to our economy, consider that the financial crisis in 2007-2008, and the subsequent recession – "The Great Recession" as many now refer to it – was largely caused by defaults on mortgages and declining home values.[v]

Given the size of the real estate market, and its corresponding importance and complexity, it is hardly a surprise that academic researchers have focused considerable attention on the topic. In fact, several universities have established specialized centers or full academic departments that focus on the real estate market (e.g. University of Wisconsin, University of Georgia). The academic literature is replete with an array of studies of real estate valuation and pricing, the market's dynamics, and countless other specific subjects. Additionally, thousands upon thousands of client-driven analyses are done each year for non-profits, businesses, trade groups, government agencies, professional real estate associations, and others.

The corpus of research is remarkably extensive, specialized, and draws on huge databases and sophisticated statistical methodologies. Increasingly, researchers are using complex analytical techniques – such as real option pricing theory,[vi] vector autoregressive regression (VAR) analysis,[vii] and other approaches that require advanced statistical techniques and sophisticated computing programming – to better understand market dynamics and anticipate future price trajectories.

Despite the attention the real estate market has received, to date no single modeling approach has proved consistently successful at either explaining current valuations or predicting future prices. Indeed, as is the case with the price of publically traded stocks, bonds, or other financial instruments, the market retains the final word. As far as academic research and understanding has progressed, when it comes to valuing assets, predicting the future remains a chimera.

Academic researchers and industry experts may, through analyzing historical, longitudinal data be able to develop a statistical projection of the likely result flowing from some change in the market environment. However, because of the complexity of both the assets (for instance, a residential property) and the real estate market in many situations, perhaps most, it is simply not possible to predict what will happen in the

future if one variable – a single characteristic or factor, particularly an exogenous one – is changed. The complexity and uncertainty – and, in some cases, impossibility – of being able to forecast real estate valuation changes in response to any single exogenous factor is the focus of this white paper.

This paper examines the situation in Oxford, CT, to provide a framework for assessing the ways in which current scholarship tries to unravel the influences on real estate valuations. In Oxford, a private company is planning to construct and operate a power plant, using natural gas as fuel, in an area that embraces eight industrial parks, many of long-standing,[viii] and close to a rapidly expanding general aviation airport,[ix] which has been in service since 1969, and has a special, adjacent Enterprise Zone.

The paper is organized as follows. The next section reviews current literature germane to both single-family housing valuation and real estate market transactions. The following section presents an overview of the situation in Oxford, CT. The Conclusion summarizes findings and, based on available research, offers an assessment of what impact constructing a power plant in Oxford, CT will have on residential property values.

OVERVIEW OF PREVIOUS RESEARCH

There is a vast amount of research and literature on real estate valuations and markets. This section does not attempt a comprehensive review of that entire body of work; rather, we focus on studies that relate specifically to single-family residential homes, and factors shown to impact valuations. We consider two categories of factors:

1) Macroeconomic variables – factors such as the level of unemployment, the economy's general output (GDP/GNP), interest rates, and the like.

2) House and/or neighborhood characteristics – factors like the number of bathrooms or fireplaces a house has, the amount of acreage it sits on, whether the property is in a neighborhood whose proximity is within a certain distance from some feature, and the like.

We begin by considering macroeconomic factors, as the literature on this subject is much richer and the findings more robust in broadly defined markets than are models based on characteristics whose qualities are apt to vary widely among large markets (such as an individual property.

MACROECONOMIC FACTORS

The Benjamin, Sirmans and Zietz (2001) paper in the *Journal of Real Estate Portfolio Management* summarizes the academic literature, including their own findings and conclusions.[x] In particular, their paper "updates the literature of real estate returns and related issues by extending previous literature surveys, specifically Sirmans and Sirmans (1987) and Norman, Sirmans and Benjamin (1995)…" Of particular interest to us is the summary of articles they include: "Several issue regarding the general nature of real estate returns [that] focus on real estate market efficiency, as measured by the distribution of returns, the predictability of real estate returns, the macroeconomic variables that may help explain variations in real estate returns, methods of measuring real estate risk and returns…." All of these studies investigate

and explore the impact that macroeconomic factors, trends, and the like have on individual house valuations, as well as how readily prices respond to changes in these broader trends.

Based on their literature review, Benjamin, Sirmans and Zietz (2001) conclude: "Macroeconomic variables sometimes are believed to be keys to understanding variances (see McCue and Kling (1994)[xi]; Mei and Saunders (1995)[xii]; Ling and Naranjo (1997, 1998)[xiii]; Lizieri and Satchell (1997)[xiv]; Eppli, Shilling and Vandell (1998)[xv]; Liang and McIntosh (1998a)[xvi]; and Viezer (2000)[xvii])." In fact, McCue and Kling (1994) found that "Macroeconomic variables such as nominal interest rates explain almost 60% of the variation in real estate prices."[xviii]

While other researchers have found different results depending on the data-sets analyzed – specifically, time-frame and location – there is more than enough evidence to support the conclusion that macroeconomic variables affect housing prices, but also that the influence of such factors dominates the impact(s) of specific property characteristics.

HOUSE & NEIGHBORHOOD FACTORS

While macroeconomic factors are clearly important – in fact, arguably the most important single group of variables – they are certainly not the only important variables when it comes to explaining variations in house prices. Prior research confirms that changes to specific characteristics have a role in determining valuations – the second category of factors. It is to this category that we now turn our attention.

To determine whether a specific – either structural or neighborhood – factor influences a property's valuation, researchers primarily rely on hedonic pricing models, which use econometric techniques to evaluate (i) whether some specific characteristic influences housing prices, and, if so, (ii) to what extent that characteristic does. Many – if not most – studies that focus on real estate valuations employ some version of this hedonic pricing technique, an approach to real estate values generally attributed to Freeman (1993)[xix], albeit based on earlier applications to other topics. The individual variables – or sets/vectors of variables – that researchers incorporate in hedonic pricing functions can vary depending on the specific focus of an analysis. For instance, Bourassa et al (2009)[xx] focus on the relationship between "green spaces" to housing prices in cities, while Lupi et al (1991)[xxi] and Doss and Taff (1996)[xxii] explore the likely impact on valuations due to how far properties are from wetlands.

The results from these studies – as well as many others not identified here by name – vary widely, with some showing positive (or favorable) shadow prices – the estimated parameters on a housing characteristic, among variables – while others demonstrate that no statistically valid relationship exists; still, others show negative results. While there are a plethora of possible characteristics that can impact housing prices, the shadow prices obtained may vary among heterogeneous locales (e.g., the estimated shadow price for double-attached garages in Ottawa is likely to be higher than the same characteristic in the Florida). As a result, estimates in multiple (different) jurisdictions are understandably likely to be different. If the jurisdictions were combined in a single study, the expected sign and magnitude of the shadow price would be unknown.

EQUILIBRIUM & MARKET EFFICIENCY

One potential reason for the variation in results is that the hedonic model requires researchers to make strong assumptions "about the housing market, including the requirement that the housing market is in *equilibrium* [emphasis added] and the study area represents one market for housing services…." The assumption that a market is in equilibrium[xxiii] is paramount, as it is a necessary condition to make generalizations about prices being both representative of an asset's underlying (or true) value, and also that the price of one asset is representative of the group, *ceteris paribus*.

For residential real estate studies specifically, the equilibrium assumption means that even though only some subset of houses actually sell in a given period, the impact on the price of houses that have some specific characteristic will in fact be the same on all other houses that share that same characteristic. Put somewhat differently, the equilibrium assumption is the accepted (if not practically accurate) convention used by researchers in modeling. By treating a given area as a single market region, researchers are then able to estimate how much impact a change in a single factor has on values.[xxiv]

One potential problem with assuming that real estate markets are in equilibrium is that, while convenient, general equilibria really only exists as a theoretical concept. Furthermore, a market in equilibrium must, by definition, exist only in a static state. Despite this theoretical constraint, hedonic models have been proven useful in identifying changes to prices from increments to one or more characteristics.

For a variety of reasons – both theoretical and practical – researchers who analyze financial markets (and transactions) rely on the concept of efficiency as opposed to equilibrium/equilibria.[xxv]

Markets are efficient if they integrate all available information into the price of an asset.[xxvi] In the case of the efficiency of real estate markets, empirical data supporting such an assumption is mixed at best. For instance, while Wilde, Wurtzler and Williamson (2014)[xxvii] find that real markets are generally informationally efficient, Case and Shiller (1989)[xxviii] determined that the single-family housing market does not meet the technical criteria for the "weak-form" of market efficiency. In their literature survey, Maier and Herath (2009) determine that, with regard to efficiency, "the result found in the literature is inconclusive," although "the market at the aggregate level seems to be surprisingly close to efficient." However, Maier and Herath (2009) also make a point of noting that there is "strong evidence of mechanisms distorting the real estate market at the micro level."

SUMMARY OF FINDINGS FROM PREVIOUS RESEARCH

Given all of the different (and differing) results that researchers have found, what (if any) general conclusions can we draw? And what can be said about the ability of researchers, academics, and professionals to predict how individual influences – the change to a specific macroeconomic variable, or specific characteristic – can, may, or will, impact housing prices? Perhaps more importantly, why should it be the case that, while so many studies have found correlations between housing prices (values) and both macroeconomic variables and specific characteristics, that there still remains considerable uncertainty regarding what impact, if any, the change in one variable – some single factor – will have on a house's value?

The difficulty in answering these questions lies in the complex nature of the asset (residential real estate) itself. Unlike other financial assets, such as stocks, bonds, or derivatives, which are comparatively uniform and share many common features, not only individual houses but entire housing markets (neighborhoods, cities, regions of a country) are extremely heterogeneous. It is this heterogeneity that makes applying any single, uniform valuation scheme to a specific situation problematic.

The greater the heterogeneity within an asset class (such as housing) the more factors there are that may influence the price of an individual asset, and the more difficult it becomes to ascertain what, if any, the change in one variable (factor, characteristic) will have on that asset's valuation. As discussed above, macroeconomic factors – such as growth in employment, or changes in interest rates (and/or interest rate expectations), or any number of other variables – clearly matter to a large extent. However, specific characteristics of the property (such as the house's age, level of upkeep, zoning restrictions, number of fireplaces, etc.) as well as those present in the neighborhood (such as proximity to the ocean, the quality of the school system, reliability of infrastructure, etc.) can also have an impact.

The ultimate result of heterogeneity in the housing market results in a situation where, while generalizations about the impact that changes to a single variable will have in some cases may be valid, it is extremely difficult (if not practically impossible) to determine what affect altering any particular factor will have to a specific property, let alone quantifying the magnitude of such a change.

Further complicating the issue is determining the net impact that conflicting factors – for instance, a situation where factors that have been shown to increase housing values occur simultaneously with those that generally decrease prices – will likely be. The most forthright response to a situation in which conflicting (positive and negative) factors are at work is to admit that generalizations are inadequate, and that one must carefully take into consideration the particular nature of each case. There are simply too many variables, whose importance varies in different instances (urban vs. rural, etc.) to categorically apply any 'rule' to a specific situation; that is, how a general finding (based on the analysis of aggregate data) will impact a particular property or set of properties at some point in the future.

The complexity of predicting future housing price trends – and, more specifically, of applying general findings to a specific situation – is the focus of the next section in this paper, where we discuss work by Lucas Davis, in which he found a correlation[xxix] between self-reported values of pre-existing homes and the construction nearby of fossil-fuel power plants.[1, xxx] While Davis's work is technically sound and certainly adds a useful perspective to the existing literature, his peer-reviewed published study has a narrow focus. However, his earlier unpublished analysis (on the same topic) in fact found no measurable impact on values when construction of the plant was known at the time of purchase.

[1] There are actually three readily available versions of Davis's papers describing his research on this topic. The three versions are not identical – in fact, the information presented in each varies to a material extent. It is not clear to which version the neighborhood group (referred to in the body of this paper) is referring. The citations/references for each of the three papers can be found in the Endnotes / References section of this paper.

THE SITUATION IN OXFORD, CT

In 1999, the Project Siting Council issued a Certificate of Environmental Compatibility and Public Need approving construction of a major power generation facility in the Woodruff Hill Industrial Park near the airport in Oxford, CT.[xxxi] Construction of the power plant has been in continuous discussion since that date; a private company has assumed responsibility, and plans to begin construction of an 805 MW natural gas-powered combined-cycle electric generating facility.

Understandably, a local neighborhood group in Oxford – comprised largely individuals who live within two or three miles of the proposed project site – has expressed concern regarding what might happen to the value of their homes after the Towantic Plant is constructed and begins operation. In support of their concerns, this group cited work by Professor Lucas W. Davis of the Haas School of Business, University of California, Berkeley.

All three versions of Davis's papers use "restricted census microdata to examine housing values and rents for neighborhoods in the United States where power plants were opened during the 1990s." Davis looks at both coal and gas fired plants. However, he does not look at individual sales of homes, but rather relies on self-reported census data at the census track level, using the location of the tract – not individual houses – to determine proximity to plants. Ultimately, Davis finds that, "neighborhoods within 2 miles of plants experienced 3%–7% decreases in housing values and rents, with some evidence of larger decreases within 1 mile and for large-capacity plants."[xxxii] Davis bases his argument for why housing prices decline on the fact that "that power plants are a source of numerous negative local externalities." These externalities are, specifically: "visual disamenities, noise, traffic, 'fugitive' emissions, and fuel residue."

The situation in Oxford – and, specifically, properties in The Village at Oxford Greens,[xxxiii] a community that opened in 2004[xxxiv] – provides a particularly interesting case study related to the general topic addressed earlier in this paper. Ultimately, the question is not whether power plants (regardless of whether they are fueled by natural gas or other fossil fuels, or something else altogether) are correlated with lower (future) housing values. But rather, given the specifics of the situation in Oxford, will the Towantic power plant have a negative impact on the home values in Oxford/Oxford Greens?

While it would appear, *prima facia*, that Davis's research provides support for the neighborhood group's concerns of a negative impact to housing values in the immediate area, closer investigation of both the specific situation and Davis's work indicates that such concerns are baseless. In fact, Davis's unpublished research, done at M.I.T. (Davis (2008)), supports the opposite projection: because the plant was licensed and sited prior to the last purchase of most or all of the homes in question[xxxv] (and, as noted above, prior to the construction of The Village at Oxford Greens) – the time at which market forces integrate all pertinent information and determine a fair price for the asset – the actual building of plant should not negatively impact the assets' value. This, combined with the consideration that the area in question has both long included industrial parks and an increasingly busy general aviation airport, argues strongly that housing values in the area already fully incorporated the impact of these nearby activities. The paragraphs below provide a fuller explanation of the basis for this conclusion.

First, the location where the Towantic power plant will be constructed on land that has been zoned for industrial use *prior* to the last purchase – if not construction – of the houses within the two mile radius Davis's analysis indicates could be impacted. Moreover, there are multiple industrial parks in the northern section of Oxford, parks which house an increasing variety of businesses. Additionally, the Waterbury-Oxford Airport, built in 1969, is one of Connecticut's fastest growing airports, with hundreds of flights a day.[xxxvi] Both industrial parks and the airport may have had a negative impact on nearby residential neighborhoods due to noise, possible visual disamenities, and perhaps emissions. However, any such disamenities have been present for quite some time now.

As discussed in the previous section, there is considerable debate in the existing literature regarding whether or not housing markets are efficient. Of particular interest to us here is how readily information is incorporated into residential real estate prices. In the Oxford case, the key element is the time-frame. While the aforementioned studies find that information is reflected in housing prices at different rates, the one thing that all research agrees upon is that, given enough time, information is incorporated, or capitalized, in the prices or values. As indicated above, Davis found exactly this phenomenon in his original research (Davis (2008)), and thus decided to exclude from his published study the instances in which he found no impact on values – those in which owners knew of the planned or actual construction of a power plant.

When we analyze the situation in Oxford, this fact is particularly important. The airport, industrial parks, and zoning and licensing for the power plant have all been in place for a considerable number of years. Therefore, there is no basis on which to believe that any negative disamenity impact would not already be reflected in the prices of the houses in that neighborhood/area. Values of any real estate asset in the area – possibly since 1969 when the airport was opened, and certainly in recent decades with the establishment of multiple industrial parks and the plans to build the power plant – would already reflect these developments.

Davis separately considered plants built between 1991 and 1995, and those built later (1996-1999), because he anticipated that for the earlier period, where construction was likely known in 1990 (his first data point for home values), the proximity of the power plant would already be capitalized (included) in self-reported home values. This is what he in fact finds; there is little evidence of impact on values for this set of homes.[xxxvii] In his published paper, Davis included only those plants built later in the 1990s, plants whose construction he assumed was unanticipated (by neighboring homeowners).

Second, even though Davis's research itself does not support the argument that the Towantic plant will impact values on homes built and purchased after its approval and siting, his research shows that in situations where power plants impact pre-existing housing, the impact on housing values (and rental rates) comes primarily at distances below one mile; that is, his analysis shows a steep gradient in impacts, with impacts falling off rapidly beyond one mile. From the data available, most of the individuals in Oxford who are concerned about the potential impact of the Towantic plant live more than a mile and a half away (using the Oxford real estate mapping, the closest homes were approximately 8,500 feet, or approximately 1.6 miles, away). As such, based on Davis's findings – even if the airport, industrial park, and zoning for the power plant were not already incorporated into real estate prices – there is scant basis on which to believe that the Towantic plant would have any material impact on the value of the surrounding homes.

Third, the issues (disamenities) to which Davis points may have little salience in the case of the Towantic power plant, which will employ new, more efficient technologies.[xxxviii] The use of these technologies will result in largely mitigating – possibly even eliminating – the negative externalities that Davis indicates negatively impact real estate values; he was looking at plants, including coal fired plants, planned in the 1970s or 1980s, then built in the 1990s, incorporating technologies now twenty years or more out of date. Specifically, using new, more efficient GE turbines and state-of-the-art emission controls (SCR, oxidation catalyst), as well as other technological improvements that were either not previously available or prohibitively expensive, the Towantic plant will minimize emissions of particulate matter, thereby directly addressing the "negative externality" of "'fugitive' emissions." Similarly, newer machinery and construction techniques minimize noise to an almost imperceptible level: current estimates show that, at about 1 mile away from the plant, the project will contribute less than 37 decibels (dBA), which is less than existing nighttime ambient levels now in the high 30s to low 40s dBA.

CONCLUSION

This paper provides an overview of relevant literature and issues on the general topic of evaluating and forecasting changes to residential real estate prices (valuations). After examining existing research, we find that while it is possible to make general observations regarding the dynamics of residential real estate markets using analytic (econometric) techniques, applying those findings without considering the specific circumstances is inappropriate. As an example of this point, we examined the specific circumstances surrounding objections to construction of the Towantic power plant, and the likely impact that it will have on the price of surrounding houses in Oxford, CT.

The situation with the Towantic plant is one where it is important to make the distinction between the aggregate and a single instance. As we have seen, research by Lucas Davis appears to support the position that construction of the Towantic power plant will have a negative impact on housing prices in the immediately surrounding area. However, upon more careful reading, we can see that his (general) findings are not in fact applicable to the (specific) situation in Oxford, CT. As is laid out in the body of this paper, the primary reasons for our conclusion are as follows.

1) While the market for residential real estate prices does not meet the technical criteria for being efficient over the short-term (Case and Shiller (1989)), given that the Towantic plant will be constructed in a location that was zoned for industrial buildings long ago, is near an industrial park, and is next to a very active airport – all conditions that existed prior to the most recent purchase (and in many cases, construction) of the houses in question. Since the real estate market is informationally efficient over longer periods (Wilde, Wurtzler and Williamson (2014)), there is every reason to believe that home values have already fully incorporated the impact of their proximity to these activities prior to the most recent purchase of the properties.

2) Even if housing prices did not already reflect the proximity to the Towantic plant, according to Lucas Davis's work, the impact on housing values (and rental rates) should not have a material impact, because any negative effect occurs primarily at distances below one mile; that is, Davis's analysis shows a steep gradient in impacts, with impacts falling off rapidly beyond one mile. In the case of Oxford, the homes in question are approximately 8,500 feet away.

3) Lucas Davis's attributes the negative impacts on house values to disamenities from fossil fuel plants. However, his analysis is from the 1990s, reflecting technologies that were available then. Since that time, new technologies have emerged, which, when incorporated into construction and/or operations – as they will be in the Towantic plant – will mitigate (if not eliminate) the disamenities Davis cites.

Ultimately, there is no way to predict for certain what will happen with regard to the prices of specific real estate assets in Oxford after the Towantic plant is constructed – there are simply too many variables, both macro- and micro-economic, to forecast the effects on any single house or group of houses. Additionally, because of the heterogeneity of real estate attributes, applying any general finding or findings based on aggregate data would be erroneous. What is clear, based on both available scholarly research and an analysis of the situation in Oxford, is that construction of the Towantic power plant will likely have no impact on the housing values in the surrounding neighborhoods.

ENDNOTES / REFERENCES

[i] http://www.federalreserve.gov/econresdata/releases/mortoutstand/current.htm.
Unique identifier: MDO/MDO/LINE1.Q.

[ii] http://bea.gov/newsreleases/national/gdp/2014/pdf/gdp3q14_adv.pdf

[iii] http://us.spindices.com/indices/equity/sp-500

[iv] http://www.federalreserve.gov/releases/z1/current/z1r-5.pdf

[v] There have been a plethora of books – not to mention articles, analyses, and reports – written about the causes and dynamics of 2007-2009 financial crisis and ensuing recession. The following are just a few of the books that provide an overview of these topics:

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[vi] For more on using option pricing techniques to value real estate, see:

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[viii] http://www.oxfordct.gov/sites/oxfordct/files/file/file/visiooxfordinsdustrialzonev3withlooproadwithtdfundingrequirementsv1.pdf

[ix] "Beginning in 2010, the FAA began a national review of the general aviation airports resulting in two reports, General Aviation Airports: A National Asset issued in May 2012 and ASSET 2 issued in March 2014." (http://www.faa.gov/airports/planning_capacity/ga_study/) The FAA categorizes the Waterbury-Oxford airport (OXC) as a "Public", "Gen Avia", "National" airport. (http://www.faa.gov/airports/planning_capacity/ga_study/media/2012assetreportappb.pdf)

[x] Benjamin, John, G. Stacy Sirmans, and Zietz. (2001). Returns and Risk on Real Estate and Other Investments: More Evidence, *Journal of Real Estate Portfolio Management*, Vol. 7, No. 3.

[xi] McCue, T. E. and J. L. Kling. (1994). Real Estate Returns and the Macroeconomy: Some Empirical Evidence from Real Estate Investment Trust Data, 1972–1991, *Journal of Real Estate Research*, 9:2, 277–87.

[xii] Mei, J. and A. Saunders. (1997). Have U.S. Financial Institutions' Real Estate Investments Exhibited ''Trend-chasing'' Behavior?, *Review of Economics and Statistics*, 79:2, 248–58.

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[xiv] Lizieri, C. and S. Satchell. (1997). Interactions between Property and Equity Markets: An Investigation of Linkages in the United Kingdom 1972–1992, *Journal of Real Estate Finance and Economics*, 15:1, 11–26.

[xv] Eppli, M. J., J. D. Shilling and K. D. Vandell. (1998). What Moves Retail Property Returns at the Metropolitan Level?, *Journal of Real Estate Finance and Economics*, 16:3, 317–42.

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[xvii] Viezer, T. W. (1999). Building Real Estate Portfolios One Deal at a Time, with an Eye on Diversification, *Real Estate Finance*, 16:3, 44–54.

[xviii] Benjamin, Sirmans and Zietz (2001)

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For additional information regarding the use of hedonic modeling techniques, see:

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[xxiii] For the classic, technical treatments of equilibrium/equilibria, see:

- Arrow, K. J., & Debreu, G. (1954). Existence of an Equilibrium for a Competitive Economy, *Econometrica*, 22(3), 265; and/or
- Debreu, G. (1959). *Theory of Value: An Axiomatic Analysis of Economic Equilibrium* (Cowles Foundation Monographs Series), Yale University Press: New Haven, CT.

For additional information on this topic, see, among others:

- Kuenne, Robert E. (1963). *The Theory of General Economic Equilibrium*, Princeton University Press: Princeton, N.J.; and/or
- Balasko, Yves. (2011). *General Equilibrium Theory of Value*, Princeton University Press: Princeton, NJ.

[xxiv] Bolitzer, B. and N.R. Netusil. (2009). The Impact of Open Spaces on Property Values in Portland, Oregon, *Journal of Environmental Management*, 59, 185-193.

[xxv] For a discussion of the differences between "equilibrium" and "efficiency" see: McCauley, Joseph L. (2011). Equilibrium versus Market Efficiency: Randomness versus Complexity in Finance Markets, *Journal of Economic Surveys*, Vol. 25, Issue 3, pp. 600-607.

For additional information regarding efficient markets (and the "efficient market hypothesis") see: Fama, Eugene F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work, *The Journal of Finance*, Vol. 25, Issue 2, pp. 383 – 417.

[xxvi] There are actually three forms of financial market efficiency: "Strong," "Semi-strong," and "Weak." Each form has its own technical criteria, or definition. For our purposes here, we use the following general definition of efficiency: "[An] Efficient market is one where the market price is an unbiased estimate of the true value of the investment." http://pages.stern.nyu.edu/~adamodar/New_Home_Page/invemgmt/effdefn.htm. For a treatment of the technical specifics/definitions of efficient markets, see, among others: Grinblatt, Mark and Sheridan Titman. (2001). *Financial Markets & Corporate Strategy*, McGraw-Hill/Irwin: New York, NY.

[xxvii] Wilde, Louis, Gail Wurtzler and Jack Williamson. (2014). Real Estate Markets Are Informationally Efficient: Evidence from Buyer and Agent/Broker Surveys, *Environmental Claims Journal*, Volume 26, Issue 3.

[xxviii] Case, Karl E. and Robert J. Shiller. (1989). The Efficiency of the Market for Single-Family Homes, *The American Economic Review*, Vol. 79, No. 1, pp. 125-137.

[xxix] The general topic of (statistical/econometric) correlation as compared to causation lies beyond the scope of this paper. The point is raised here, as Davis's studies – references in subsequent Endnote – consider statistical correlations. As Davis noted in one version of his paper, "… it is difficult to disentangle the causal impact of power plants on housing values." (Davis, 2008, pp. 2) For more on the general topic of correlation versus causation in econometrics, see, among others:

- Basmann, R. L. (1988). Causality Tests and Observationally Equivalent Representations of Econometric Models. *Journal of Econometrics*, Vol. 39, Issues 1–2, pp. 69-104.
- Cox Jr., L. (2010). Regression versus Causation, Revisited. *Risk Analysis: An International Journal*, Vol. 30, Issue 4, pp. 535-540.
- Skyrms, Brian. (1988). Probability and Causation. *Journal of Econometrics*, Vol. 39, pp. 53-68.
- Zellner, Arnold. (1979). Causality and Econometrics, *Carnegie-Rochester Conference Series on Public Policy*, Vol. 10, pp. 9-54.

[xxx]The references for Lucas Davis's three papers are:

- Davis, Lucas W. (2011). The Effect of Power Plants on Local Housing Values and Rents. *The Review of Economics and Statistics*, Vol. 93, Issue 4, pp. 1391-1402.
- Davis, Lucas W. (2010). The Effect of Power Plants on Local Housing Values and Rents. Haas School of Business, University of California, Berkeley, CA, http://faculty.haas.berkeley.edu/ldavis/pp.pdf.
- Davis, Lucas W. (2008). The Effect of Power Plants on Local Housing Values and Rents: Evidence from Restricted Census Microdata. Center for Energy and Environmental Policy Research, http://web.mit.edu/ceepr/www/publications/workingpapers/2008-009.pdf.

[xxxi] For background information regarding the property/site, see: Findings of Fact for Connecticut General Statutes (CGS) §4-181a(b) Proceeding (http://www.ct.gov/csc/cwp/view.asp?a=958&q=330602), as well as associated materials/information from the Connecticut Siting Council.

[xxxii] Davis (2011), Abstract

[xxxiii] http://www.oxfordgreens.org/o/ohome.asp

[xxxiv] http://www.55places.com/connecticut/communities/the-village-at-oxford-greens.

[xxxv] Based on publically available data from the Oxford, CT Assessor's Office. (http://www.oxford-ct.gov/assessor)

[xxxvi] For information regarding the airport, see:

- http://www.gcr1.com/5010web/airport.cfm?Site=OXC
- http://www.ct.gov/dot/lib/dot/documents/ddotinfo/waterburyoxford/finalampu.pdf
- http://www.ct.gov/dot/lib/dot/plng_studies/oxcpart150study/executivesummary.pdf

[xxxvii] Davis (2008)

[xxxviii] See, among others:

- Gambini Marco, Vellini Michela. (2007). Natural Gas Decarbonization Technologies for Advanced Power Plants. *Journal of Engineering Gas Turbines Power*, 129, 1114-1124.
- Leff, Harvey S. (2012). Thermodynamics of Combined-Cycle Electric Power Plants. *American Journal of Physics*, 80, 515-518.
- Narula, R. G., Wen, H., and Himes, K. (2001). Economics of Greenhouse Gas Reduction—The Power Generation Technology Options, "Proc. of 18th Congress World Energy Council", Buenos Aires, Argentina, October 21–25.
- Petros A. Pilavachi, Stilianos D. Stephanidis, Vasilios A. Pappas, Naim H. Afgan. (2009). Multi-Criteria Evaluation of Hydrogen and Natural Gas Fuelled Power Plant Technologies. *Applied Thermal Engineering*, Vol. 29, Issues 11–12, pp. 2228-2234.
- http://electrical-engineering-portal.com/an-overview-of-combined-cycle-power-plant